AOIT Computer Networking

Lesson 7

Network Standards and Protocols

Teacher Resources

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Teacher Resource 7.1

Interaction Activity: Tribe Behavior Protocols

Separate the class into six groups and give each group one of the following prompts. Explain that each group is receiving special instructions about its cultural customs. Give students some time to come up with a name for their tribe and to practice their greeting within their group.

(If it is a multicultural class with a few distinct groups of first-generation students from similar cultural backgrounds, students might be grouped homogeneously and use their own cultural customs.)

Once students have completed the activity, discuss the results per the lesson plan instructions and introduce students to the concepts of standards and protocols. Also discuss why it’s important to agree on a “protocol" for the way people are expected to behave.

Tribe 1

Your people come from a very friendly tribe. Your custom is to greet people by reaching out your right arm and shaking the other person’s hand.

Tribe 2

Your people come from a very friendly tribe. Your custom is to greet people by raising your right hand, waving in a friendly gesture, and saying “Hello.”

Tribe 3

Your people come from a very friendly tribe. Your custom is to greet people by pressing the palms of your hands together and bowing.

Tribe 4

Your people come from a very friendly tribe. Your custom is to greet people by reaching out both your hands and shaking their hands enthusiastically.

Tribe 5

Your people come from a very friendly tribe. Your custom is to greet people by reaching out your right hand, performing a handshake, then bumping your fists together, knuckles to knuckles.

Tribe 6

Your people come from a very friendly tribe. Your custom is to greet people by nodding and saying, “Nice to meet you.”

Teacher Resource 7.2

Assessment Criteria:   
Protocols and Standards Presentation

Student Names:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Using the following criteria, assess whether the students met each one.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Met | Partially Met | Didn’t Meet |
| The presentation correctly describes the main functions of the protocol or standard. |  | □ | □ | □ |
| The presentation correctly identifies the components, cables, or devices that use the protocol or standard. |  | □ | □ | □ |
| The presentation correctly identifies the subject as a protocol or a standard, and explains why it is one or the other. |  | □ | □ | □ |
| The presentation includes contributions from all students in the group. |  | □ | □ | □ |
| The information is presented in a creative way. |  | □ | □ | □ |

Additional comments:

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Teacher Resource 7.3

Guide: OSI Seven-Layer Model

Introduction to the OSI Seven-Layer Model

The OSI (Open Systems Interconnection) seven-layer model describes a framework for how network data is processed. Each layer performs a set of steps to package the data before it is sent to the network, or to unpackage it when it’s coming in from the network. At the bottom layer, information is just an electric signal. As it goes through the layers, different network protocols take their turns processing the information. By the time it reaches the top layer, the information has been translated from a series of electric signals to a message that we can understand. Finally, it shows up in a software program, like Internet Explorer or Instant Messenger, where we can read it.

We can imagine the OSI seven-layer model like a seven-story building. A message that the postman brings in on the first floor has to travel in the elevator to an office on each floor of the building. On each floor, a secretary has to look at it and change it according to his protocol. Once all the secretaries do their work, the message finally gets sent to the company president on the top floor. The secretaries are the protocols, and the president is you, the end user.

The model was developed in 1984, and some of the newer protocols used today don’t fit neatly into the framework, but it is still a good way to understand how the different processes for packaging data are ordered and categorized.

**Diagram of the OSI 7-Layer Model**

Computer 2

|  |
| --- |
| 7. Application |
| 6. Presentation |
| 5. Session |
| 4. Transport |
| 3. Network |
| 2. Data Link |
| 1. Physical |

Computer 1

|  |
| --- |
| 7. Application |
| 6. Presentation |
| 5. Session |
| 4. Transport |
| 3. Network |
| 2. Data Link |
| 1. Physical |

Upper Layers:

Applications (Software)

Lower Layers:

Data Transport



Network Data Flow

The upper layers of the model deal with how the software processes the information inside the computer. Both you and the upper-layer protocols interact with the software programs that are on your computer.

The lower layers of the model handle the issues concerning the flow of data outside the computer: packaging the information to prepare it for traveling across the network, and sending it. Some of these changes happen in the software and some of them happen in the hardware.

As data is packaged to be sent out to the network, it moves down from the application layer toward the physical layer. Each layer adds a new header about the information, and where and how it’s to be sent. Information also gets included about how the packets are sequenced, or organized. Once it’s received by the next computer, the packaged information travels back up through the layers. Each layer unpackages the information, and some check for errors. Then, the information is translated until it’s readable on the application layer, when it reaches your eyes.

The Physical Layer (Layer 1)

This layer is what we’ve covered so far in class. It includes all the physical, tangible parts of the network that can be touched, like cables and devices, as well as the electric signals. But objects on this layer cannot interpret those signals in any way. For this reason, we say they have no intelligence.

Layer Devices and Protocols

Ask students which devices and protocols would fit under this layer, and why. Make sure they can identify the following:

* **Network cables:** Unshielded twisted pair (UTP), coaxial, fiber optic
* **Hubs:** Have no intelligence to read addresses or data
* **Repeater:** Reshapes and resends the electric signal along
* **Network interface card (NIC):** Sends electric signals (A NIC is partly also at the data link layer, so you may want to mention that to avoid confusion.)

Worksheet Activity

Find information about a computer’s network adapter and write down the network adapter device type, manufacturer and physical location.

Instructions:

* Access the Device Manager and select Network Adapters.
* View the properties of the network adapter.
* Find the computer’s MAC address and write it down. (To obtain the MAC address, enter the getmac command at the command-line prompt.)

The Data Link Layer (Layer 2)

This layer is separated into two parts:

**1. Media Access Control (MAC)**

This part provides MAC addresses to identify network nodes, which allows us to send data across the network. It handles getting the data bits from the NIC to the cable by translating the hexadecimal values the NIC understands into the binary values that can be sent via electric signal.

**2. Logical Link Control (LLC**)

This part functions like an office waiting room for the data being sent. It has a certain amount of memory for storing information that is being sent out to the cables from the computer. When the computer wants to send something, it first collects the data in this area, called the buffer, and then sends it piece by piece. The buffer controls the flow of data, which is called flow control.

LLC also checks for errors using a checksum. After data arrives, the LLC adds up all the data bits that have arrived and checks the sum against the number of bits that it expected. If the amount isn’t right, it asks the sender to resend the entire message.

Layer Devices and Protocols

**Switch:** Controls the flow of data coming from one computer’s MAC address and directs it to the next MAC address destination (computer). Also records MAC addresses—so if problems arise with a switch, troubleshoot by rebooting, which empties out the old addresses and refreshes the switch’s memory.

**Bridge:** Controls data flowing between two local network segments or across two networks; also can function as an intelligent repeater that is aware of MAC addresses.

**Network interface card:** While the NIC is a physical device, it also operates on the data link layer, in the sense that it has the intelligence to translate the hexadecimal values into a binary electric signal and send that across the cable, and translate incoming signals back to hexadecimal for the computer to understand.

Worksheet Activity

Use a converter to translate the computer’s MAC address, which is written in hexadecimal, into a binary signal that can be sent electrically across an Ethernet cable. You can use the Windows calculator in scientific mode (click View 🡪 Scientific) or look up any of the following websites:

* <http://cgi.linuxfocus.org/~guido/javascript/convert.html>
* <http://www.easycalculation.com/hex-converter.php>
* <http://www.dewassoc.com/support/msdos/decimal_hexadecimal.htm>

Class Activity

As a class, compare the speed of a hub, which operates on the physical layer and doesn’t have the intelligence to understand MAC addresses, with that of a switch, which operates on the data link layer. Connect several computers to the hub and download a file or video, and time how long it takes. Then, connect several computers to the switch and perform the same download. Record the times. Try this a few different times, and see whether the switch is faster.

The Network Layer (Layer 3)

This layer is a connection-less layer which handles routing of data across the network or other destination networks. It controls the Internet Protocol (IP) addresses, which are assigned by an administrator or via DHCP to computers on a local network. IP addresses are based in the software, unlike the MAC address, which is tied to the hardware—the physical NIC.

Layer Devices and Protocols

**Routers:** Used to divide large LANs into smaller segments, or used on a home network to connect to the Internet.

**Gateway:** Used in larger networks to connect LANs to the Internet. Like routers that understand multiple protocols.

**Firewalls:** Both routers and gateways can serve as a perimeter firewall and block traffic based on IP addresses.

Worksheet Activity

In the DOS environment, run the ipconfig command to find the computer’s IP address. (The command ipconfig/all will also give all sorts of other information.)

The Transport Layer (Layer 4)

The transport layer, is connection-oriented and allows the sender and receiver to establish a connection in order to send data, then provides acknowledgement when a message is received. It also checks for errors to make sure the data is received and reordered properly. If errors exist, the data is resent. There are two types of Transport protocols used, TCP (Transmission Control Protocol) and UDP – User Datagram Protocol.

Layer Devices and Protocols

**TCP:** Packages packets for sending, checks them as they arrive, and puts them in order (called sequencing).

**Flow control:** The transport layer controls the bitstream once it’s on the Net.

Note: You may or may not want to discuss ports. Computers listen on different ports, or pathways, for information coming in or flowing out of the network. Different functions use different ports—HTTP uses port 80; HTTPS uses port 443. Security can be partially controlled by closing doors or ports that aren’t being used. Ports are technically part of the TCP protocol and are handled by the transport layer.

Worksheet Activity

Open a web browser and visit a few websites in different windows. In the DOS environment, run the netstat –n command to check network status.

The output will show all the IP addresses of websites you’re connected to. List all foreign IP addresses in the worksheet.

The Session Layer (Layer 5)

This layer sets up a connection for an ongoing “session” for an application that remains connected for a period of time, such as an instant messaging program. Before the connection is established, the two sides agree what the “rules” will be: they explain what speed to connect at, what protocols to use, and whether the transmission will be encrypted. This negotiation is called the “handshake” because it is an initial greeting/agreement. Once established, the session layer protocols also manage the session and terminate it once it’s complete.

Layer Devices and Protocols

* **Instant messaging (IM)**
* **Online real-time games**

Worksheet Activity

What programs on the computer initiate a session as they connect?

Class Activity

Load an IM session and describe the process as it is connecting. It hooks in to the server where other people are logged in, authenticates, and establishes the connection. Have two students IM each other. Is there a lag? Why or why not?

The Presentation Layer (Layer 6)

This layer controls how the information is presented to the upper layer (Application), translating binary data to text (ASCII).

It also compresses data so that it takes fewer bytes to send the message across a network, thus speeding up the connection. An example: WAV music files are large files, so we put them into MP3 format so that they take up less space. MP3 is an audio compression standard.

This layer also controls encryption for security purposes, so that when information is sent, no one can intercept the transmission and capture logins, passwords, credit card numbers, or other personal information. Only some types of connections use encryption. Students can look for the *https* in a URL to see if information is being sent across a secure connection.

Layer Devices and Protocols

**Secure Sockets Layer (SSL):** Web servers that use login portals, such as banks, use an SSL connection to encrypt the login information and other data sent in. Websites using SSL can be identified by their URLs, which begin with *https://* rather than *http://*.

Worksheet Activity

What are some websites that use encryption to secure the data? Look for the *https://* in the URL.

Class Activities

Many schools block eBay and other HTTPS sites. If they aren’t blocked, find websites using this security and see how the padlock symbol is displayed in different browsers (e.g., Firefox and IE). Look at popular social networking sites like MySpace and Facebook as well as bank sites.

Have one student send a text message to another via the IM session initiated earlier. Talk about how the information is translated from ASCII text to binary as it’s sent, then back to ASCII. Time whether there is any lag in how long the message takes to arrive.

The Application Layer (Layer 7)

Everything on the computer screen involves the application layer. The layer isn’t the apps or software themselves, but how they communicate with the network. For example, a Word document itself isn’t the application layer, but if you click in Microsoft Office Word Help to go to the Internet to troubleshoot a problem, the communication is on the application layer.

The application layer also controls authentication, where applications identify users based on a login and password. It determines whether enough computer resources such as memory, and enough bandwidth, are available.

Layer Devices and Protocols

**Internet browsers:** Internet Explorer, Firefox, Safari

**Desktop email clients:** Microsoft Outlook, Thunderbird

**Other Internet-going applications:** Telnet, FTP

Worksheet Activity

Which application layer programs do you use most often?

Class Activity

Open various common applications and discuss whether or not they are considered application layer applications; for example, Microsoft Excel vs. Internet Explorer.

The OSI Seven-Layer Model — Mnemonics for Memorization

Here are some examples to spark students’ ideas as they develop their own mnemonic for remembering the layers of the OSI Seven-Layer model:

* **A** "**P**erfect" **S**ystem **T**hat **N**ever **D**id **L**ook **P**erfect
* All People Seem To Need Data Processing
* Please Do Not Take Sales-People's Advice
* Please Do Not Throw Sausage Pizza Away

Teacher Resource 7.4

Assessment Criteria: OSI Seven-Layer Model Collage

Student Names:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Using the following criteria, assess whether the students met each one.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Met | Partially Met | Didn’t Meet |
| The written description accurately answers each of the questions about the steps of the assigned layer. |  | □ | □ | □ |
| The collage includes several images that accurately represent the layer’s function, steps, or devices and the protocols it uses. |  | □ | □ | □ |
| The collage includes imagery representing where the layer lies in the model in relation to the other six layers. |  | □ | □ | □ |
| Students describe how the images used on the collage represent the functions of the layer. |  | □ | □ | □ |
| The description and collage are labeled with the layer’s title, and the work is neat, with no grammatical or spelling errors. |  | □ | □ | □ |

Additional comments:

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Teacher Resource 7.5

Key Vocabulary: Network Standards and Protocols

These are terms to be introduced or reinforced in this lesson.

| Term | Definition |
| --- | --- |
| application | A computer application is a software program. In the OSI seven-layer model for computer networking, the application layer (the seventh level) controls how the programs interact with the network, by determining whether enough computer resources are available and controlling user authentication. |
| authentication | Using a login, password, or other identifier to verify a user’s identity for security purposes. |
| buffer | Functions on the second layer of the OSI seven-layer model, the data link layer. Like a lobby waiting room for data, it stores information before the information is sent to the network. |
| buffer overflow | The buffer can contain only so much information, so if too much is sent too quickly, the computer experiences a buffer overflow. |
| checksum | The Logical Link Control (LLC) sublayer of the data link layer in the OSI seven-layer model checks for errors in the data stream by adding up the bits that arrive and checking the total amount against the amount it expected to receive. If the total, or checksum, doesn’t match, the stream is resent. |
| client | A client is a computer, or an application on a computer, that requests files such as images, documents, websites, or databases from a network server. For example, an email client (such as Microsoft Outlook or Mozilla Thunderbird) is an application that allows users to send and receive email from their computer. |
| data link | The second layer of the OSI seven-layer model. Separated into two segments, the Media Access Control (MAC) layer and the Logical Link Control (LLC) layer, it controls how information is translated from pure physical data into information the computer understands. Also checks for errors in the data transmission. |
| Dynamic Host Configuration Protocol (DHCP) | Client computers use this protocol to obtain IP addresses from the server so that they can connect to a local area network or the Internet. |
| encryption | A method for keeping data private and secure by translating it into a secret code and requiring a password to decrypt it. |
| flow control | The methods and protocols used to adjust the flow of data across a network so that it is sent and received successfully. |
| frame | Refers to a packet of data as it is being sent across the network. In Serial Line Internet Protocol (SLIP), a frame is the code of information used to show where the packet starts and ends. |
| hexadecimal | The base-16 number system using numbers 0–9 and letters a–f. Number 15 of the decimal (common) number system is notated as F in hexadecimal. Hex is a step between decimal and binary, and can represent each byte of binary notation (8 bits) with one letter. |
| Hypertext Transfer Protocol (HTTP) | Controls how your client computer pulls web graphics, web pages, and information from a web server and displays them in your browser. |
| IEEE 802 | A family of standards for computer networking that is composed of many different protocols and defined by IEEE, the Institute of Electrical and Electronics Engineers. This family of standards controls Ethernet, wireless communications, and more. |
| layer | The OSI seven-layer model breaks up the process of preparing data for the network into seven layers. The protocols used for networking are split into categories based on what they do, and fit into these layers. However, since it is just a model, some protocols don’t fit neatly into the layers. |
| MAC address | The Media Access Control (MAC) address associated with a network adapter or network interface card. |
| model | A diagram or description that represents a system or phenomenon, used to explain, understand, and explore how it functions. |
| network handshake | The agreement achieved when two computers open a network session by establishing a connection and determining what protocols to use while communicating. |
| network segment | A cluster of computers attached by a switch or router. |
| OSI (Open Systems Interconnection) | *OSI* is short for the OSI reference model or OSI seven-layer model that defines a framework for using protocols by separating the functions of the network into seven layers. |
| physical | The first layer of the OSI seven-layer model, containing all the tangible cables and devices on the network, as well as electric signals. |
| Point-to-Point Protocol (PPP) | The current standard that replaces SLIP as the method for putting headers on data packets. It is used only in point-to-point direct connections. It operates in the second layer of the OSI seven-layer model and provides features that check for errors when the information is sent. |
| presentation | The presentation layer, sixth in the OSI seven-layer model, controls how information is presented to us. Also allows for encryption and compression. |
| protocol | A set of formal rules describing how to transmit data across a network. |
| Secure Sockets Layer (SSL) | A method of security that encrypts and protects data as it travels through the network. |
| Serial Line Internet Protocol (SLIP) | A simple protocol for adding a frame to packets that tells the network where the packet begins and ends. Used in direct, point-to-point dial-up connections only. Today, SLIP is mostly outdated. |
| server | A computer that stores documents, web pages, or databases for other computers on the local network to retrieve. Also controls how data packets are routed within the local network and sent to the Internet. |
| session | The fifth layer of the OSI seven-layer model; allows for establishing ongoing connections for applications such as instant messaging. |
| standard | A rule for group behavior that is mandated by a governing body or agreed on by general consensus. |
| Transmission Control Protocol (TCP) | Enables two host computers to establish a connection and ensures that packets are sent properly and put into the correct order when received. |
| transport | The fourth layer of the OSI seven-layer model, the transport layer makes sure data is sent and received properly across the network and checks for errors. |
| user | The end user or computer user is the person working on the computer that sends and receives messages through the network. |

Teacher Resource 7.6

Bibliography: Network Standards and Protocols

The following sources were used in the preparation of this lesson and may be useful to you as classroom resources. We check and update the URLs annually to ensure that they continue to be useful.

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